U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Overview: Materials Technology Program

Gurpreet Singh, Program Manager (Acting)

Materials Technology Program
Vehicle Technologies Office

Jerry Gibbs, Sarah Kleinbaum and Felix Wu






Improve Fuel Economy with Lightweight and Propulsion Materials [FY20 Budget: $40M]

Lightweight Materials -

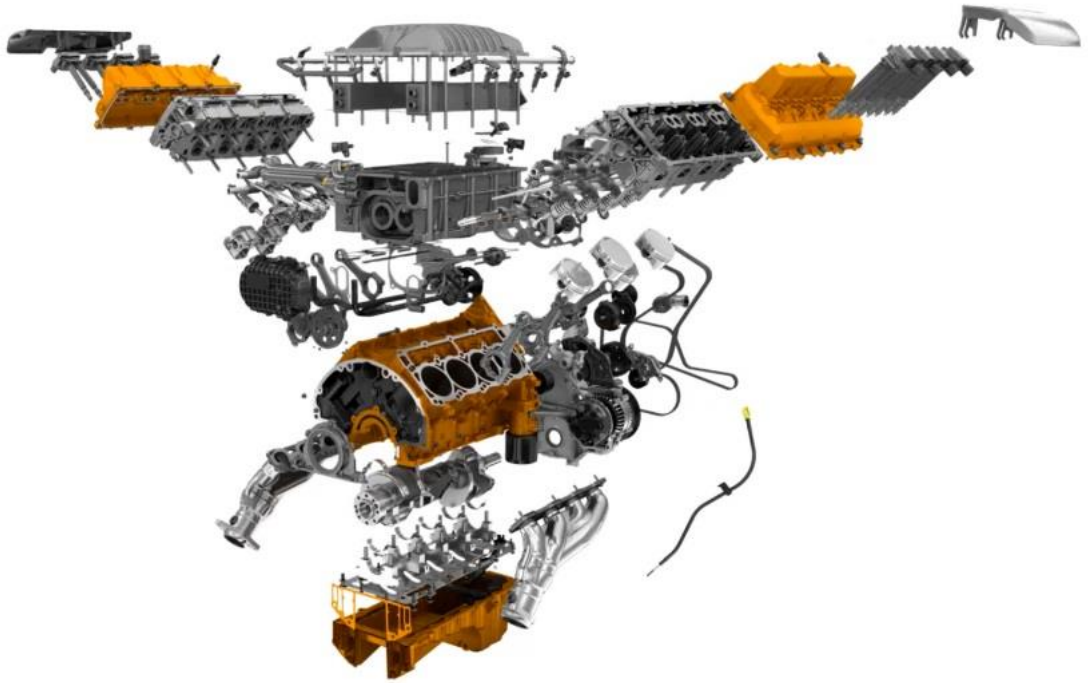
Research areas include:

- Sheet Metals (Al, AHSS, Mg)
- Carbon Fiber Composites
- Multi-Material Joining

Propulsion Materials –

Research areas include

- Cast Metals (Al, Cast Iron, Stainless Steel)
- High Temperature Alloys (500 – 1100 C)



Program Goals: 25% glider weight reduction at less than $5 / lb-saved by 2025 and 25% improvement in high temperature component strength by 2025.

Carbon Fiber Composites - a success story

H. Felix Wu, TM

Advantages:

- High specific strength, specific stiffness, and specific energy absorption
- Parts consolidation, Complex geometry molding
- Significant weight reduction for fuel economy improvement

Challenges:

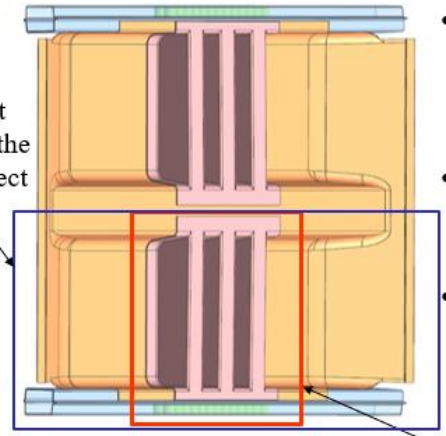
- High raw material and manufacturing cost
- Limited availability of computational tools capable of design validations

Solutions:

- Integrate manufacturing with structural performance models using Integrated Computational Materials Engineering (ICME) approach – cradle to grave
- High volume manufacturing methods
- Multi-functionality to make business case

Demonstration:

2016 GM-Malibu Best in its Class
Light Weight Steel
Rocker Floor Assembly
Weight = 68 Kg

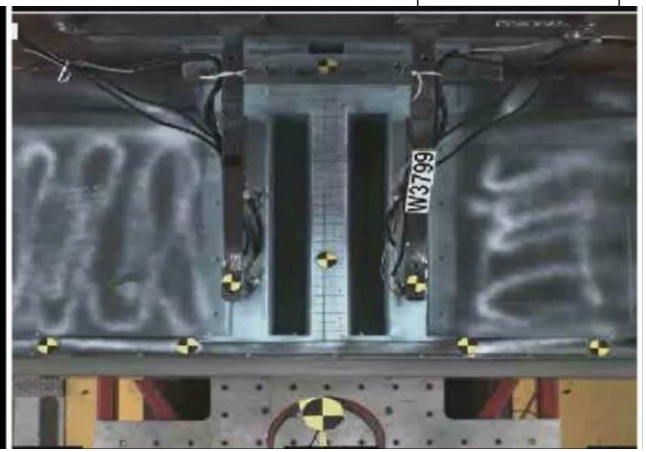


Replacement Carbon Fiber
Assembly Weight = 48 Kg

- Parts consolidation from 81 steel parts to 9 composite parts
- Carbon fiber design is 30% lighter than steel
- Further optimization is expected to improve the weight savings to ~ 40%

Portion of the assembly built for the prototype evaluation

High Strength Steel Design
(intrusion 221 mm)



Carbon Fiber Design
(intrusion 115 mm)

VTO Composites R&D Strategy (2021-2023)

H. Felix Wu, TM

FOA (VTO/AMO)

- Topic: *Lightweight, High-Performance Fiber-Reinforced Polymer Composites for Vehicle Applications*
- Objective: Achieve significant weight reduction through the development of novel materials, composite preforms, and manufacturing processes for high-volume, high-performance, and affordable fiber-polymer composites for vehicle components
- Funding: $15,000,000
- Estimated award selection: 2-4

FOA (HFTO/VTO/AMO)

- Topic: *Advanced Carbon Fiber for Compressed Hydrogen and Natural Gas Storage Tanks*
- Objective: to significantly reduce the cost of high-pressure compressed H2 and natural gas storage tanks through the development and demonstration of low-cost, high-tensile strength CF production and consideration of end-of-life materials reuse and recycling.
- Funding: $15,000,000
- Estimated award selection: Up to 3

Lab Call

- Topic: *Composite Materials and Structures R&D*
- Objective: Investigate core innovation early-stage research projects at National Laboratories focused on polymeric matrix composites to address fundamental-crosscutting issues and/or incubate novel concepts for low cost, high-volume, high-performance vehicle components
- Funding: $5,030,000
- Number of awards selected: 11

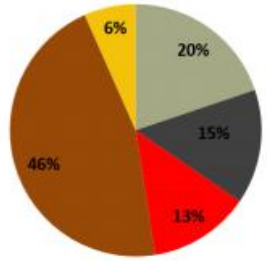
SBIR/STTR (Phase I)

- Topic: *Multi-functional Composite Materials & Structures*
- Objective: Reduce weight and costs of structural components by performing engineering functions beyond load carrying. The structure can sense, diagnose, and respond for adjustment with minimum external intervention; allow alternation of shape functionality and mechanical properties on demand; and structural integration of power harvest/storage/transmission capabilities for “self-sustaining” systems
- Funding: $200,000 per award
- Number awards selected: 4

Joining Difficult Dissimilar Material Pairs at PNNL, ORNL and ANL

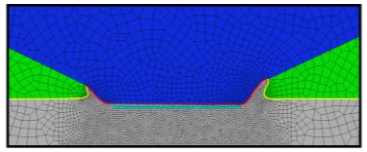
Sarah Kleinbaum, TM

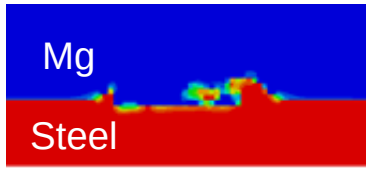
- The lightest weight vehicles will be made from a mix of Advanced High Strength Steel, Aluminum, Magnesium, and Polymer Composites
- Developing both novel joining methods and fundamental understanding of these new interfaces

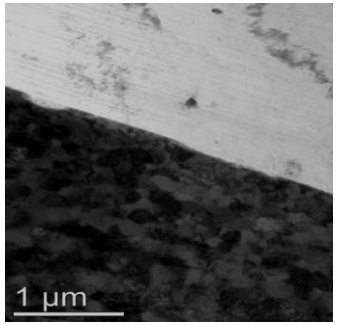


ALUMINU`M SHEET | COMPOSITE | ALUMINUM CASTING
PRESS HARDENED STEEL | MAGNESIUM SHEET

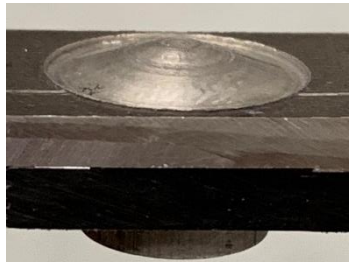
Determined nature of metallurgical bond between immiscible Mg and Steel

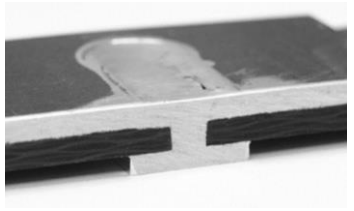


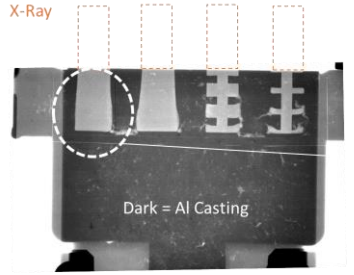




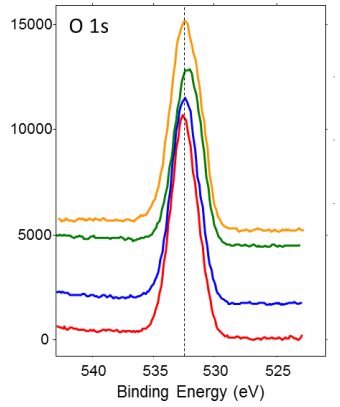
Demonstrated multiple viable methods for mechanically joining Mg or Al to CFRP

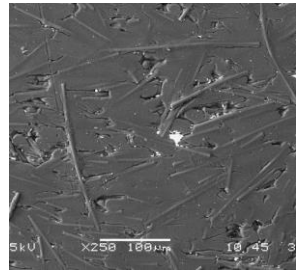






Improved bond strength of adhesive joints between Mg, Steel and CFRP through better understanding of surface treatments



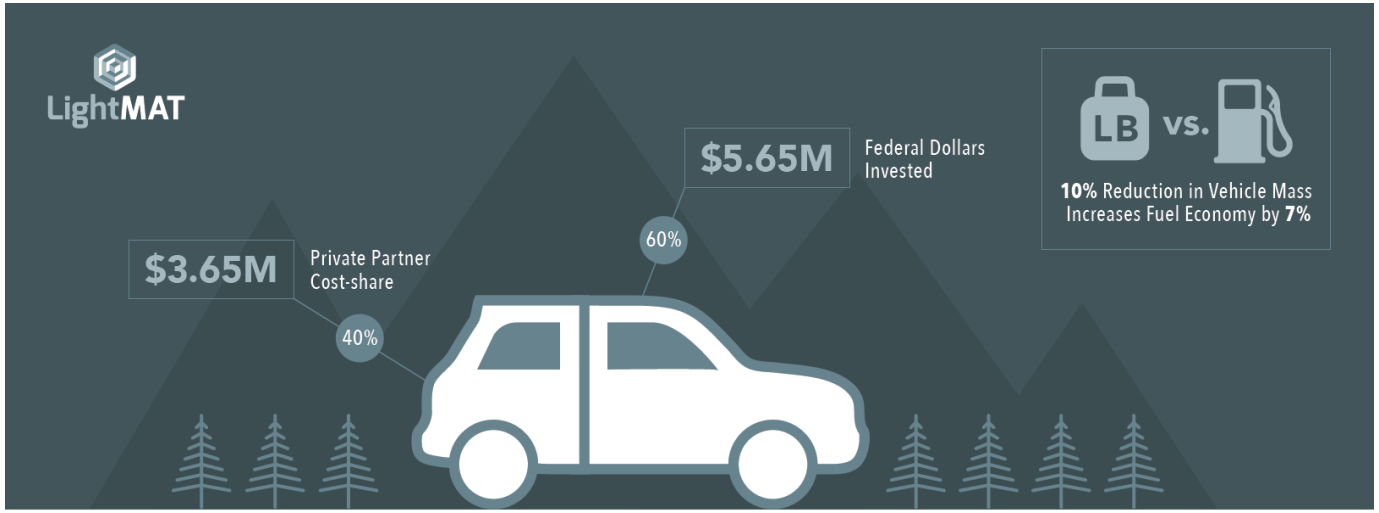


LightMAT: A Multi-Lab Consortium for Accelerating Lightweight Materials Development

Sarah Kleinbaum, TM

Objective: Facilitate connections between industry and National Lab resources to accelerate lightweight materials development and provide access to unique scientific and technical resources:

- high resolution and non-destructive characterization,
- Novel synthesis and processing of materials,
- and high-impact predictive modeling.



11 National Laboratories

14 Partner Organizations

142 Cross Network Capabilities

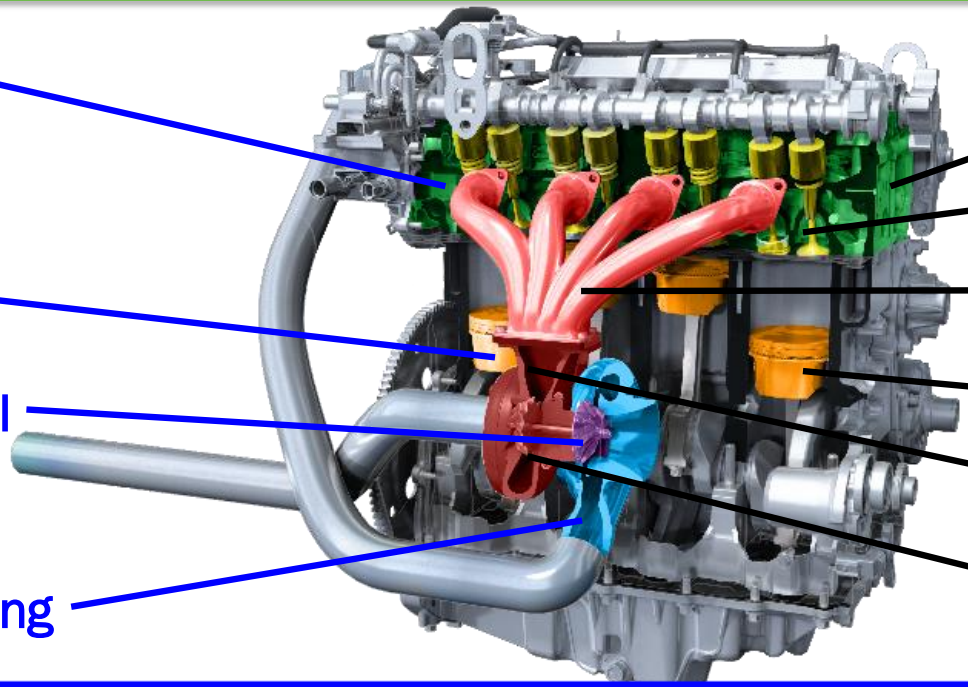
13 Total Projects

Mallinda malleable thermoset CF with <3 minute forming time. Supported by ORNL, PNNL and SNL

FY20 Direct Funding Opportunity is currently open. For more information, please visit the website:

www.LightMAT.org

The Powertrain Materials Core Program is applying an Integrated Methodology to address critical powertrain component materials needs



Thrust 1. High Temperature Lightweight Alloys <500C (low – mid TRL)

Thrust 2. Higher Temperature >500C (Ni-, Fe-based) Alloys (low - mid TRL)

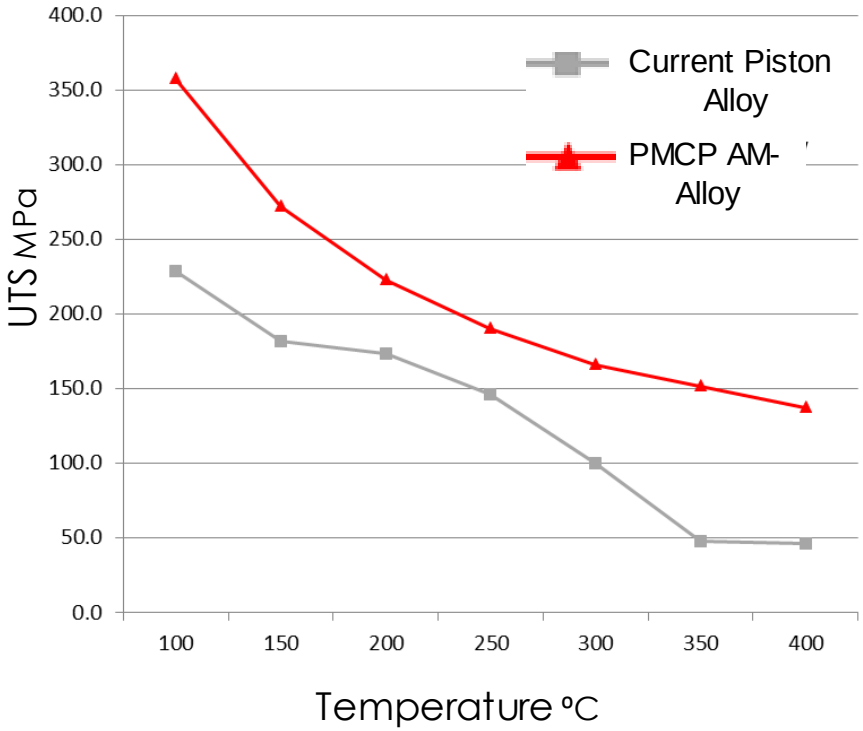
Thrust 3. Additive Manufacturing and Exploratory Research (Low TRL)

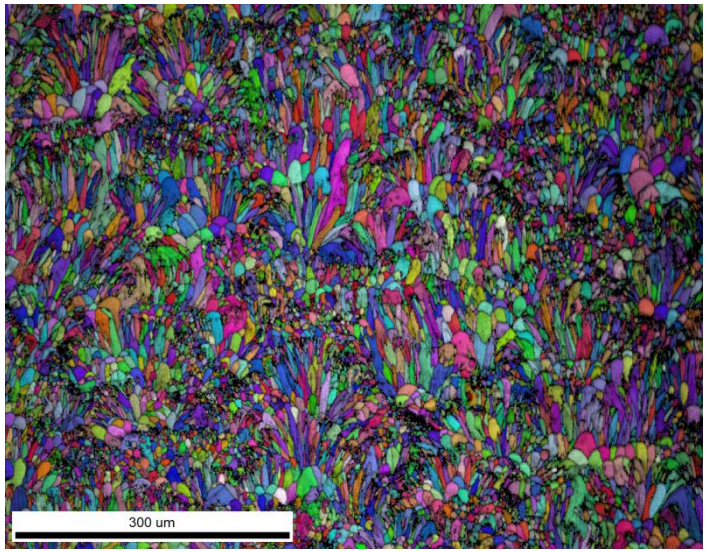
- Matrix of "World Class" Material Scientists, Advanced Characterization capabilities, and High Performance Computational (HPC) resources from 3 National Laboratories

The Powertrain Materials Core Program has Designed and Characterized a number of Alloys for Additive Manufacturing (AM) – Potential AM piston alloy is shown

Jerry Gibbs, TM

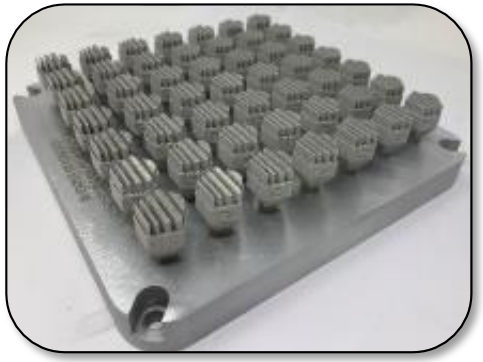
- Example system ➔ Al-Cu-Ce-Zr
- Very hot cracking resistant alloy with attractive mechanical properties





Unique Microstructure

Printed Component using the new alloy



Rapid Production Parameter Evaluation

Thank You

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Web site:

Vehicle Technologies Office

www.vehicles.energy.gov

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